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Phytoremediation of Groundwater at Air Force Plant 4 Carswell, Texas

Innovative Technology Evaluation Report

SITE
SUPERFUND INNOVATIVE
TECHNOLOGY EVALUATION

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Phytoremediation of Groundwater at Air Force Plant 4

Carswell, Texas

Innovative Technology Evaluation Report

National Risk Management Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
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Foreword

The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce environmental risks in the future.

The National Risk Management Research Laboratory (NRMRL) is the Agency's center for investigation of technological and management approaches for reducing risks from threats to human health and the environment. The focus of the Laboratory's research program is on methods for the prevention and control of pollution to air, land, water, and subsurface resources; protection of water quality in public water systems; remediation of contaminated sites and ground water; and prevention and control of indoor air pollution. The goal of this research effort is to catalyze development and implementation of innovative, cost-effective environmental technologies; develop scientific and engineering information needed by EPA to support regulatory and policy decisions; and provide technical support and information transfer to ensure effective implementation of environmental regulations and strategies.

This publication had been produced as part of the Laboratory's strategic long-term research plan. It is published and made available by EPA's Office of Research and Development to assist the user community and to link researchers with their clients.

Hugh McKinnon, Director
National Risk Management Research Laboratory

Abstract

A demonstration of a Phytoremediation Groundwater Treatment system was conducted at the Carswell Naval Air Sation (NAS) Golf Club in Fort Worth, Texas to investigate the ability of purposely planted eastern cottonwood trees, *Populus deltoides*, to help remediate shallow TCE-contaminated groundwater in a subhumid climate. Specifically, the study was undertaken to determine the potential for a planted system to hydraulically control the migration of contaminated groundwater, as well as biologically enhance the subsurface environment to optimize in-situ reductive dechlorination of chlorinated ethenes present (trichloroethene and cis-1,2-dichloroethene) in the shallow aquifer system beneath a portion of the golf course. *Populus deltoides*, like other phreatophytes, have long been recognized as having the ability to tap into the saturated zone to extract water for metabolic processes. Based upon this characteristic the species was considered well suited for applications where shallow aquifers are contaminated with biodegradable organic contaminants. A planted system of cottonwood trees is believed to effectuate two processes that aid and accelerate contaminant attenuation. First, transpiration of groundwater through the trees is believed to be able to modify and hopefully control the hydraulic groundwater gradient. This can minimize the rate and magnitude of migrating contaminants downgradient of the tree plantation. Secondly, the establishment of the root biomass, or rhizosphere, promotes microbial activity and may enhance biodegradative processes in the subsurface. To assess the performance of the system, hydrologic and geochemical data were collected over a three-year period (August 1996 through September 1998). In addition to investigating changes in groundwater hydrology and chemistry, the trees were studied to determine important physiological processes such as rates of water usage, translocation and volatilization of these volatile organic compounds, and biological transformations of chlorinated ethenes within the plant organs.

The demonstration site is situated about one mile from the southern area of the main assembly building at Air Force Plant 4 (Plant 4) at the Carswell NAS. The assembly building is the primary suspected source of TCE at the demonstration site. The evaluation of this technology application was a joint effort between the U.S. Air Force (USAF), the U.S. Geological Survey, the U.S. Forest Service, the Department of Defense's (DoD's) Environmental Security Technology Certification Program (ESTCP), and the U.S. EPA's SITE program.

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Acronyms, Abbreviations and Symbols

A	Cross-Sectional Area of Aquifer
AACE	American Association of Cost Engineers
AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
AQCR	Air Quality Control Regions
AQMD	Air Quality Management District
ARARs	Applicable or Relevant and Appropriate Requirements
ASC/ENV	Aeronautical Systems Center Acquisition, Environmental, Safety and Health Division
ATTIC	Alternative Treatment Technology Information Center
BGS	Below Ground Surface
BFDP	Biofuel Feedstock Development Program
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CERI	Center for Environmental Research Information
CFR	Code of Federal Regulations
CGC	Carswell Golf Club
cm/s	centimeters/second
cm	Centimeter
CWA	Clean Water Act
d	day
DCE	Dichloroethene
DO	Dissolved Oxygen
DoD	Department of Defense
DoE	Department of Energy
ESTCP	Environmental Security Technology Certification Program
ft	feet
g	gram
gptpd	Gallons per Tree per Day
ha	Hectare
hr	Hour
I	Hydraulic Gradient
IRP	Installation Restoration Program
ITER	Innovative Technology Evaluation Report
K	Hydraulic Conductivity
Kg	Kilogram
m	Meter
m/d	meters/day
MCLGs	Maximum Contaminant Level Goals
MCLs	Maximum Contaminant Levels
mg/L	milligrams per liter

Acronyms, Abbreviations and Symbols(Cont'd)

mm	Millimeter
MPN	Most Probable Number
NAAQS	National Ambient Air Quality Standards
NAS	Naval Air Station
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRMRL	National Risk Management Research Laboratory
O&M	Operation & Maintenance
ORD	Office of Research and Development
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
PA	Preliminary Assessment
PCBs	Polychlorinated Biphenyls
POTW	Publicly Owned Treatment Works
PPE	Personal Protective Equipment
Q	Volumetric Flux
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SAIC	Science Applications International Corporation
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SITE	Superfund Innovative Technology Evaluation
SWDA	Solid Waste Disposal Act
TCE	Trichloroethene
TEAP	Terminal Electron-Accepting Process
TER	Technology Evaluation Report
TOC	Total Organic Carbon
TSCA	Toxic Substances Control Act
TSD	Treatment Storage and Disposal
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VC	Vinyl Chloride
VISITT	Vendor Information System for Innovative Treatment Technologies
VOCs	Volatile Organic Compounds

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